

**ON FIVE NEW SPECIES OF THE GENUS  
*HABROTROCHA*.**

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PLATES 38 AND 39.

IN the following paper I describe five new species of pellet-making Rotifera, which are to be added to the already important genus *Habrotrocha*. The first two, *H. insignis* and *H. sylvestris*, may be said to belong to the central group of the genus, being closely related to *H. angusticollis* (Murray), which has been designated as type species by Woodcock.\* The characteristics of this central group consist of a relatively long and slender head and neck, a middle body distinctly stouter, and an exceedingly short foot, together with rather narrow trochal disks borne on somewhat high pedicels usually adnate. *H. insignis* has other more special characteristics, one of which has not been seen in any other Bdelloid. The upper lip, when closely examined, is found to have a curious stiffening, apparently that it may better support the slender pedicels under the strain of the lashing cilia above. This stiffening is not very obvious, but once observed is readily recognised and can be detected even when the corona is retracted within the mouth.

A second interesting structure is the looping of the gullet in a certain position of the body. A similar structure has been already noted by Zelinka for *Habrotrocha Leitgebii*, and it is also present in two of the other new species, viz. *H. sylvestris* and *H. flava*. The looping of the gullet is one of several structural modifications that are distinctly connected in their origin with the attitude assumed by the rotifer when it is feeding. There are some Bdelloids of the family of the Philodinidae which feed without attempting to extend themselves, but others extend themselves habitually to the utmost, without doubt in order to

\* Woodcock, *Int. Cat. Sci. Lit.*, vol. x., 1911. *Zoology*, vi. p. 45.

gather food from the increased area thereby brought within the influence of the vortices set up by the cilia of the trochal disks. This habit of extension for the purpose of increasing the food supply reacts in two different ways upon the structure of the body. One of these is very apparent in such species as *Rotifer vulgaris* and its nearer relatives, where the foot and the rump segments have become so elongated that they constitute quite a large proportion of the whole length of the animal.

In the central section of the Habrotrochae the head and neck are lengthened to a marked extent, whilst the rump and foot segments, and especially the latter, become or remain relatively short and unimportant. The neck frequently becomes so slender that the mastax is pushed backwards into the last segment of the neck when the animal is crawling, and into the anterior segment of the trunk or central body when it is feeding. The increasing distance from the mouth to the mastax necessitates in turn a longer gullet, which is fully but not tensely stretched out when the animal displays its corona. When the latter is withdrawn, the inversion of the mouth reduces the distance to the mastax, and the connecting gullet becomes slack. In extreme cases the slackness is so great that the gullet, which is usually a little stouter near the mastax, bends over, just above the stouter part, towards the ventral side, and so forms a loop, which is not straightened out until the corona is again everted. It is very difficult to see the loop distinctly. The animal must be observed in side view and at the moment when the neck is fully extended, for the gullet is not truly "looped" if it straightens out before the eversion of the corona.

In some species a further modification is seen. Not only is the mastax shifted rearwards, but also the brain, which is normally so placed that the narrow anterior end is close to the dorsal antenna, while the broader posterior part more or less overlaps the mastax. In *H. insignis* the anterior end of the brain is placed about one-half the brain-length behind the antenna, and this also is best seen in lateral view. I find that this modification of the position of the brain does not obtain in all the slender-necked Habrotrochae, and it seems therefore to be a character useful for the differentiation of such species.

*Habrotrocha insignis*, again, is one of the few species of Bdelloid

Rotifera which not only can endure life in the most exposed situations, but which even seems to prefer it. It would be difficult in Great Britain to find mosses growing in bleaker places than on the tops of the Scottish and Welsh mountains, yet wherever in such elevated places mosses can be found growing and braving the storms, this species, sheltering in the moss-tufts, seems able to flourish exceedingly well.

In many respects the new species *Habrotrocha sylvestris* is closely allied to *H. insignis*, but the upper lip is not so high, and lacks the curious stiffening so distinctive in the latter. On the other hand *H. sylvestris* has a unique character of its own. In certain Distylae (for example, *D. depressa*) the lower end of the oesophagus (which seems to project into the stomach cavity) has an incessant undulatory movement. I found a similar movement of the oesophagus in *H. sylvestris*, where it has probably some connection either with the formation of the food-pellets or with their discharge into the stomach.

Both *H. insignis* and *H. sylvestris* are probably of near relationship to *H. tridens* (Milne), which, however, I judge, from the description and figure given, to be an altogether more slender and cylindrical animal than either. I have not been able to identify it with certainty.

The third species described, *Habrotrocha pavidā*, is of quite a different type, and is notable for its moderately wide corona, and the bulging lateral margins of the mouth, which give it a very characteristic outline when favourably seen. Although it has been known to me for many years, it has, with one exception, only been found in moss growing among the grass in a small suburban garden. It is a very timid species, and will rarely feed unless it is ensconced in a convenient "heap" of sand or debris, from which it protrudes its head "at mealtimes." In an earlier paper \* I have described the manner in which the food-pellets are moulded in the case of *H. constricta* (Dujardin). In *H. pavidā* there is a little more elaboration of the process. If a good lateral view can be obtained while the animal is feeding, the greater part of the oesophagus can be seen, albeit somewhat indistinctly. The inner surface of the tube is apparently lined with cilia, for there is an almost continuous undulatory move-

\* Bryce, "Further Notes on Macrotrachelous Callidinae," *Journ. Quek. Micr. Club.*, Vol. V., Ser. II., pp. 436-455. No. 35, 1894.

ment carrying along the food particles towards the end farther from the mastax. Arrived near that end, they become incorporated in a pellet, which is revolved at moderate speed until it is large enough to be expelled into the wide stomach, where its revolving motion ceases. The growth of the pellet at its beginning could not be seen, but perhaps a minute or so after the expulsion of one pellet there could be discerned a tiny mass which, revolving slowly, gradually increased in bulk, the whole process lasting from five to ten minutes if the animal continued feeding steadily. The undulatory movement of the oesophagus seemed to be similar to that frequently observable in the gullet, and less violent than that of the oesophagus in *H. sylvestris*, and, further, it seemed to cease if no particles of food were being passed along, just as it does in the gullet.

Like all the foregoing species, *Habrotrocha flava*, sp. nov., is a dweller in ground moss, although on one occasion I found it in moss which had been growing on a roof, but becoming detached had rolled into the roof gutter. It is a brightly coloured species, for whilst the whole body in the adult is distinctly yellowish, the colour of the stomach deepens almost to a bright rust-red. The corona has a somewhat unusual structure which I later describe in detail, and the many-toothed rami, the stout foot and wide separation of the spurs make this an easily recognisable species.

A very different habitat is characteristic of *Habrotrocha longula* sp. nov., which shows a preference for mosses and algae, growing in running water in the more mountainous districts, where it is constantly found in company with *Philodina flaviceps* Bryce and *Philodinavus paradoxus* (Murray), which also delight in such situations.\* This species has the same habit as *H. pavida* of taking shelter in any available aggregations of sand or debris. The stomach in adult examples is usually vividly coloured in tints of pinkish red. Its elongate form, short foot, and peg-like spurs, held nearly parallel, seem to show relationship to

\* I have occasionally met with a form nearly related to *H. longula*, perhaps identical with it, in submerged confervae or mosses growing upon artificially made edges of town ponds and in watercress in a country ditch, but I have not had the opportunity of comparing any of the few examples thus found with my notes or sketches of the form now described.

*H. elegans* (Milne), which, however, has a narrower corona and a still shorter foot.

***Habrotrocha insignis*, sp. nov.**

Pl. 38, fig. 1.

*Specific Characters*.—Head and neck long, slender; trunk much stouter; foot very short. Corona narrow, three-fourths of collar width; disks dorsally canted and separated by notch; pedicels rather high, slender, adnate. Upper lip undivided, rising nearly as high as pedicels, centrally rounded, stiffened by rigid bent rod of staple-like outline. Mastax far back; rami with three teeth each. Gullet long and looped. Brain remote from antenna. Spurs short, acute cones, without or with little interspace.

When crawling this species bears some resemblance to *Habrotrocha angusticollis* (Murray), when the latter is seen out of its case. The skin of the long head and neck is so smooth that it has a somewhat bright and tight appearance. That of the trunk is finely punctate or stippled along the longitudinal skin-folds, which are distinctly marked, the four central extending over the preanal segment. In well-grown examples the trunk is somewhat long and so much stouter than the neck as to give a somewhat swollen appearance. It gradually increases in size up to the fourth central segment, the succeeding preanal segment being nearly as large, and the anal much smaller, and so rapidly diminishing to the end of the short three-jointed foot. The slender rostrum has rather prominent lamellae. In front of the antenna is seen within the head a curious structure, which may be likened to a thin, rigid rod bent into the form of a staple, but which may be the thickened margin of a concave plate having that outline. No similar structure has yet been detected in any other species. When the corona is protruded this bent rod or plate is seen to be external on the dorsal side of the upper lip. The points of the uprights are now directed forwards (having pointed backwards while the corona was hidden), and the closed end to the rear, about level with the anterior margin of the base of the retracted rostrum. In dorsal view the uprights diverge very slightly, the points reaching the anterior edge of the upper lip on each side, not far from the centre. In lateral

view they are seen to be curved and to enclose a concave area. Whether bent rod or plate, the structure seems to be a support for the high upper lip, and indirectly for the slender pedicels. The under lip is only moderately prominent, but in lateral view the sides of the mouth seem rather high. Behind the mouth I saw several faintly marked annular plicae. The positions of the mastax and of the brain and the looped gullet have been described above.

The short foot tapers rapidly and is about equal in length to one-sixteenth of the whole body. On the dorsal surface of the proximal joint, just behind the anus, is a strong thickening of the hypodermic skin, conspicuous in lateral view when the animal is extended. When feeding most of the foot is retracted within the body, and the extremity is covered by the rump. When the animal is crawling there is no slithering movement. The antenna is of moderate size.

Like many of its near relatives, this species is exceedingly timid. When it ventures to display its corona it usually adopts very curious positions. A favourite position is attained by the animal bending the head and neck back until the corona nearly touches the rump, and then turning the head half round so that the corona presents a lateral and inverted view. Poses of this character are frequently seen among tube-dwelling species with long, slender necks, and it would not be surprising if *H. insignis* should later be found to belong to this section, although no tube-dwelling habit has yet been observed. It is, of course, equally possible that it may have been a tube-dwelling species in the past.

An example isolated laid eggs of usual type, oval, smooth and hyaline, and measuring  $66\ \mu \times 46\ \mu$ .

My largest examples measured about  $290\ \mu$  in length, the rami  $15\ \mu$ , the spurs 4 to  $5\ \mu$ ; the corona about  $20\ \mu$  wide, and the collar about  $26\ \mu$ .

First obtained in ground moss from Baden (? Schwarzwald) in 1894, and thereafter in moss collected by Mr. D. J. Scourfield on Cader Idris in 1895; in moss from the top of Ben Vrachie (Perthshire) in 1908; in liverwort collected by Mr. G. K. Dunstall near Lynton (North Devon) in 1914, and in rock moss from the summit of Snowdon (Wales), gathered by Mr. Lionel Bennett in the same year.



***Habrotrocha sylvestris*, sp. nov.**

Pl. 39 fig. 2.

*Specific Characters*.—Head and neck slender, elongate; trunk much stouter. Corona narrow, disks scarcely separated, much canted to dorsal side; pedicels adnate, obliquely truncate, hidden in dorsal view by upper lip, which rises in bold curve nearly to edge of disks, and is centrally obtusely angled and moderately deep. Gullet long, looped. Brain close to antenna. Mastax set far back when feeding. Rami with two and three teeth respectively. Foot short, usually hidden. Spurs short, acute, conical, slender, divergent. Oesophagus with constant (?) undulating movement.

I have seen only some five or six examples of this species, which seems to be closely related to *H. angusticollis*. It differs very markedly in the form of the under lip, which is not produced into a spout-like front, but simply rounded like the edge of a cup. When feeding, a few annular wrinkles are visible on the ventral and lateral surfaces of the head about the level of the retracted rostrum, and to right and left of the antenna are two minute decumbent processes. The animal crawls in a rather leisurely fashion. On one occasion I saw a rough tube, partly secreted, partly of entangled particles, and I have seen eggs measuring about  $70\ \mu \times 40\ \mu$ , of normal outline, smooth and hyaline.

I have no record of the length when extended, but estimate it about  $220\ \mu$ . When feeding, the individual figured measured about  $190\ \mu$ .

Several examples were found in ground moss collected by Mr. A. W. Sheppard in St. Leonard's Forest, Horsham, in 1909. Another was detected in moss sent me by Mde. Montet, of Vevey, Switzerland, and one other in moss from the Black Forest, Baden, which the late Mr. John Stevens, of Exeter, had received and kindly shared with me.

***Habrotrocha pavid*a, sp. nov.**

Pl. 38, fig. 2.

*Specific Characters*.—Body gradually increasing to greatest width near rump, thence rapidly diminishing; foot small, of

three joints, hidden except spurs. Corona rather wider than collar, pedicels separated by moderate sulcus. Upper lip low, central portion slightly produced to about level of nexus between pedicels, rounded and undivided. Sides of mouth with strong external prominences. Rami obtusely angled, each with four teeth. Spurs slender, acute, held nearly parallel, sometimes slightly incurved, decurved, claw-like, bases separated by interspace nearly equal to spur length. Toes three, small, conical.

In adults the whole body is tinged with yellow, and sometimes the skin is slightly viscous. It usually attains its greatest width in the hinder part of the fourth central segment, and thence narrows rapidly to the small foot, which is so hidden beneath the rump that even when crawling only the spurs can be seen in dorsal view. In this it resembles *Habrotrocha elegans* (Milne), but the body is generally stouter, the increase in size rearwards more marked, and the spurs are not peg-like. When disturbed it crawls about very actively. The corona is wider than is usual in the genus, exceeding the width of the collar. This is not obvious, for the lateral margins of the mouth have each a strong rounded external prominence, which are visible in dorsal view, and, being exactly at the level of the collar, add to the apparent width of the latter. A similar effect has been seen and described in *Calledina angusta* Bryce, and I have also seen it in *Calledina aculeata* (Milne), but in these species the prominences are angular and rather less conspicuous. The post-oral segment has an annular thickening of the skin, rising to small bosses at right and left of the base of the antenna. The neck and gullet are not unusually long, and the brain is close behind the antenna. The rami are somewhat triangular in outline, and have each four well-marked teeth. When feeding, the foot and the greater part of the rump segments are usually withdrawn or hidden beneath the trunk. The spurs are rather slender and acute, held almost parallel, the inner side almost straight, the outer slightly curved, somewhat decurved and claw-like, and have their bases separated by a moderately wide interspace; altogether they are of an unusual and rather distinctive form.

The stomach usually contains pellets of good size. The process of their formation has been described above.

This very distinct species seems to take up its position in



the leaf axils of certain small ground mosses, and to gather round it an accumulation of particles within which it shelters, and possibly thus makes a tube of a most elementary description. It produces eggs of broadly ovate form, with rather obtuse ends, shells smooth and hyaline, measuring about  $76\ \mu \times 51\ \mu$ .

Length, extended, about  $270\ \mu$ ; feeding, about  $170\ \mu$ . Rami,  $20\ \mu$ . Spurs,  $6\ \mu$ . Width of corona,  $38\ \mu$ .

*Habitat*.—Moss among short grass in my garden, Stoke Newington, and (one individual only) in tree moss from Norton's Heath, Essex.

### *Habrotrocha flava*, sp. nov.

Pl. 38. fig. 3.

*Specific Characters*.—Corona spreading, yet little wider than collar. Pedicels high, sub-adnate. Upper lip undivided, rising rather high to rounded tip. Neck moderately long; gullet looped; mastax far back; rami with six or seven teeth each. Foot very short and stout; spurs short, strongly decurved, widely separated and diverging; interspace very convex.

A species of moderate size with several distinctive characters. While apparently allied to the long-necked species of the genus, the head and neck are less slender than is customary in that section. The adults are frequently conspicuous from the vivid yellowish red of the stomach and the paler tint of the remainder of the body. The corona appears to be of unusual type. In place of the pedicels being straight, slightly diverging or parallel columns, they seemed to be separated at their bases, to approach each other at half height, and thereafter to diverge; the inner line of each showing thus a bold curve in dorsal view. Yet they seemed to be connected by a delicate membrane from their bases to near the plane of the trochal disks. I could discern on the dorsal line an unusually faint line marking, as I thought, the outline of a very delicate upper lip, and farther back in front of the retracted rostrum a much stronger line moderately curved crossing the head. The head is rather elongate when the corona is displayed, and the mastax is then usually in the first and occasionally in the second trunk segment. The gullet is long and is looped when the animal is not feeding. The anterior of

the brain is a little way behind the dorsal antenna. When feeding, this species usually conceals the whole foot below the rump segments. The foot has, I think, three segments, the second somewhat disk-like and carrying two widely separated spurs, which in dorsal view seem to be short, stout cones, but are really only moderately short and strongly decurved. The interspace between them is strikingly convex, and about  $12\ \mu$  wide. Two strong and broadly truncate toes were seen repeatedly; a third was possibly present, but not detected. On the post-oral segment there is a small prominence on either side of the short antenna.

Length,  $320\ \mu$ . Rami,  $21\ \mu$ . Corona,  $23\ \mu$  wide.

In ground moss at Mundesley and roof moss at Paston, near Mundesley; also in ground moss collected by Mr. G. K. Dunstall, in Surrey.

### **Habrotrocha longula, sp. nov.**

Pl. 39, fig. 1.

*Specific Characters.*—Rather elongate and slender; body nearly cylindrical; foot very short. Corona wider than collar; pedicels separated by narrow gap; disks slightly canted to dorsal side. Upper lip rising to moderately high, obtuse, median point. Brain long, anterior close to antenna, posterior just overlapping mastax. Gullet not looped. Rami somewhat triangular, longish, each with five teeth. Spurs short, stout pointed cones, held nearly parallel.

In searching washings of moss or algae from stones in swiftly running streams in hilly districts or near the shores of mountain lakes, one frequently finds this species in numbers, and marching about with much pertinacity, though not with much speed. It attracts attention by its bright colour, the alimentary tract being frequently of a vivid orange-red to pink-red tint, and the remainder of the body of a much paler shade. If left undisturbed, the various individuals take shelter after a time in convenient "heaps" of particles, or of "floccose," and will presently commence to feed and so settle down to satisfy their healthy appetites. I have sometimes been able to see a rudimentary secretion of a case, and have no doubt that a certain amount of

viscous fluid is produced in some such way to bind together the sheltering particles or fibres. In several respects this rotifer has marked affinity to *Habrotrocha elegans* (Milne), which has a similar shelter-taking habit. But the head and the corona are larger in proportion, the foot is less hidden beneath the rump; the spurs are stouter, though rather like in style and pose, and the teeth of the rami are five in number.

When feeding, the animal usually bends the anterior part of the body, protruded from the "shelter," to one side or the other, or even backwards, but I have not seen any extravagant contortions of the neck. It lives fairly well in small troughs, and even in small cells I have kept it for over two months.

The form and proportions of the upper lip as shown in fig. 1a (Pl. 39) seem rather distinctive. The lateral margins of the mouth are slightly prominent, but less so than in *H. pavida*. The underlip is slightly produced and spout-like. In one case I saw the pellets being formed at a distance of about  $15\ \mu$  behind the rami, and the oesophagus seemed to be from 20 to  $25\ \mu$  long. The pellets made are small to moderate in size. On several occasions the rather long and normally placed brain seemed to me to show reddish blotches as of suffused pigment, but I failed to detect any definite eye-spots, such as are so distinct in the cognate *Habrotrocha collaris* Ehrbg. When apparently fully protruded the dorsal antenna measured about  $19\ \mu$ . In the feeding position it is inclined forwards, almost resting against the retracted rostrum, but towards the tip it is slightly recurved.

The terminal foot joint is stout at the base, but tapers rapidly, and on two occasions I have seen three short, stout, truncate toes protruded.

The eggs are laid within the "shelter" and are of oval outline, smooth and hyaline; measuring about  $57\text{--}60\ \mu$  in longest, and  $39\text{--}40\ \mu$  in shortest diameter.

Length,  $300\text{--}350\ \mu$ . Spurs,  $6\ \mu$ . Width of corona,  $35\text{--}38\ \mu$ .

From rock moss from summit of Ben Vrackie, Perthshire (1907). In moss close to a waterfall near Milford, South Wales, collected by Mr. G. K. Dunstall. In encrustation of stones from Untersee, and in mosses from Mittersee, Lunz, Austria, sent me by Dr. von Brehm, of the Lunz Biological Station (1911-13).

DESCRIPTION OF PLATES 38 AND 39.

Plate 38.

- Fig. 1. *Habrotrocha insignis*, sp. nov., dorsal view, feeding position.  $\times 590$ .  
 „ 1a. Head and neck, corona displayed, in lateral view.  $\times 590$ .  
 „ 2. *Habrotrocha pavida*, sp. nov., dorsal view, feeding position.  $\times 590$ .  
 „ 2a. Same, in lateral view.  $\times 590$ .  
 „ 2b. Rami.  $\times 1,180$ .  
 „ 2c. Foot, showing spurs and toes.  $\times 590$ .  
 „ 3. *Habrotrocha flava*, sp. nov., dorsal view, feeding position.  $\times 590$ .  
 „ 3a. Part of foot, showing spurs.  $\times 590$ .

Plate 39.

- Fig. 1. *Habrotrocha longula*, sp. nov., dorsal view, extended.  $\times 590$ .  
 „ 1a. Dorsal view, feeding position.  $\times 590$ .  
 „ 1b. Head and neck, corona displayed, in lateral view.  $\times 590$ .  
 „ 1c. Rami.  $\times 1,180$ .  
 „ 2. *Habrotrocha sylvestris*, sp. nov., dorsal view, feeding position.  $\times 590$ .  
 „ 2a. Head and neck, corona displayed, in lateral view.  $\times 650$ .  
 „ 2b. Rami.  $\times 1,180$ .  
 „ 2c. Spurs.  $\times 590$ .